

Matt S - Practical Assignment

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Contents

Contents	1
1 Test Data	3
1.1 Meteorological data	3
2.2 Area of Interest	5
3 Initial Inspection.....	5
3.1 Area Visit	5
4 Spots Limitations.....	8
4.1 Ingress Protection	8
4.2 Field of Vision	8
4.3 Spots Go & No Go Areas	8
4.4 Battery Life	9
4.5 Handler Proximity	10
4.6 Conclusion on Suitability	10
5 Drone	11
5.1 Contrast.....	11
5.2 Settings and Limitations.....	12
6 Landmine Collection and Logging	1
6.1 Collection Table.....	1
7 Summary	3
7.1 Remote Sensing	3

List of Figures

Figure 1: Area of Interest	5
Figure 2: Flooding Location	6
Figure 3: Flood Risk	7
Figure 4: Spot - Workable Area	8
Figure 5: Workable Area	9
Figure 6: 30m Radius.....	10
Figure 7: Drone Operator - Proximity to nearest point of the area of interest	11
Figure 8: Landmine Locations	2

List of Tables

Table 1: Hardware Table	4
Table 2: Software Table	4
Table 3: Landmine Locations from Photograph Geotag Data.....	1

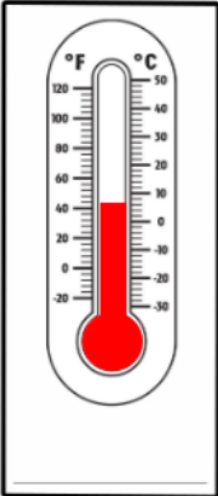
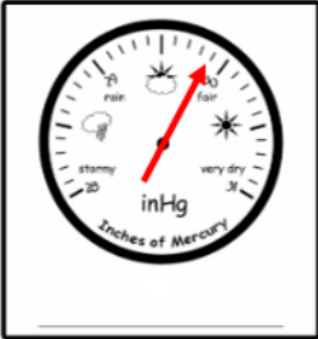
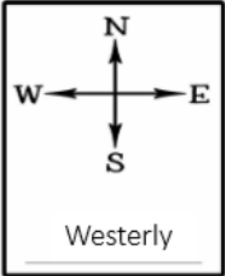
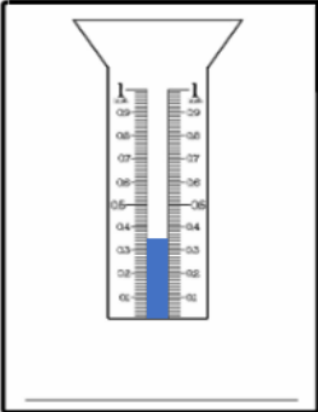
List of Equations

Equation 1: The time taken for Spot to Survey the entire area, Including battery changes.	9
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1 Test Data

1.1 Meteorological data

1.1.1 The meteorological data collected is detailed below :

Time and Date of Project		
Thursday 16 th November 2023 14 : 00		
Air Temp	Air Pressure	Wind Direction
		
	Rainfall	Initial Observations
		Sunrise 07:41
		Sunset 16:27
Wind Speed		Ground still exposed to sunlight and heating
12mph		Visit Purpose
		Remote assessment of potential minefield

2.1 Hardware

2.1.1 The full list of test hardware is shown below :

Table 1: Hardware Table

Hardware	Model	Specifications and Extras	Operator(s)
Robotic Dog	Boston Dynamics Spot Mk4	Infrared Camera Camera Remote Access	UWTSD
Drone	DJI Mavik 2	Infrared Camera 4K Camera Aerial Observations	UWTSD
Camera	Samsung S10 Pro	Geotagged Imagery	Matt Satterthwaite

2.1.2 Remote data, as well as general mapping will be processed on the following software :

Table 2: Software Table

Software	Version	Use	User
QGIS	Desktop Version 3.32.3	Mapping Geotagging Visualization	Matt Satterthwaite
DJI Thermal SDK	Window Version 1.4	Infrared image and video processing	UWTSD

2.2 Area of Interest

2.2.1 The proposed area of interest is highlighted below :



Figure 1: Area of Interest

3 Initial Inspection

3.1 Area Visit

3.1.1 A site visit was conducted prior to the deployment of the remote sensing equipment to establish the most efficient method of data collection.

3.1.2 Pictures were taken from the extents of the site to document this visit and justify any decisions. The photo log is detailed below:

No.	Time Taken	Direction of Photo	Longitude	Latitude	Comments	Photo
1	14:21	Reading Failed	51.616	-3.927	Banks and Verges – area not flat	

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2	14:32	67° NE	51.616	-3.927	Large puddle / Area of flooding	
3	14:25	313 NW	51.616	-3.928	Telegraph Pole Downed	
4	14:29	169 S	51.616	-3.927	Differing Surfaced included hard standing	
5	14:44	28 NE	51.616	-3.928	Proposed Drone Launch and Land Pad Location	

3.1.3 As mentioned in line 2, there was a large area of flooding located during the site inspection. The exact location is detailed below:



Figure 2: Flooding Location

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- 3.1.4 This feature was captured on the google satellite imagery however, given the nature of the task, it is still important to determine whether that is a permanent feature or a product of recent heavy rainfall.
- 3.1.5 Land mines could have been planted here prior to rainfall and would now be submersed under cold water, making them difficult to identify using thermal imagery.
- 3.1.6 Flood data, via the geological map layers was added to the satellite image to determine whether this area is commonly prone to flooding.

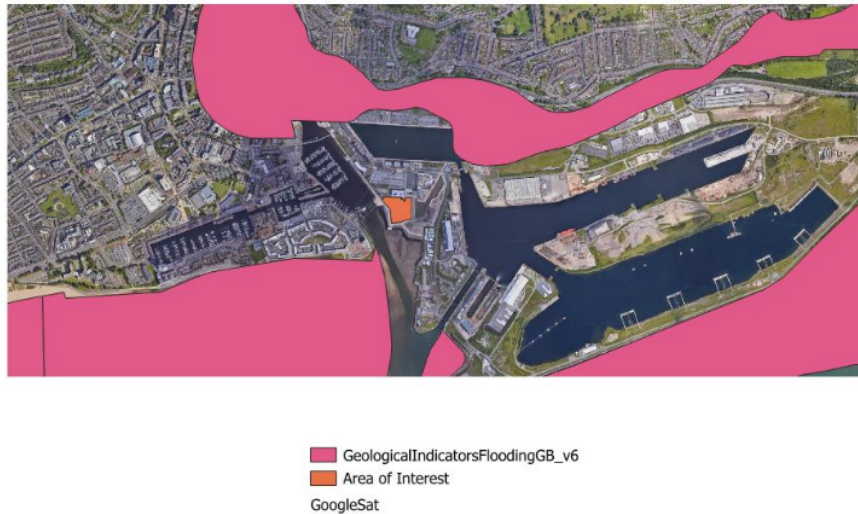


Figure 3: Flood Risk

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- 3.1.7 Figure 3 shows that the area of interest is not a known flood risk, therefore it is likely a new feature that has developed since the data was collected. This is likely due to the additional construction and infrastructure in the area.

4 Spots Limitations

4.1 Ingress Protection

- 4.1.1 Spot has an IP rating of 54, this means that he is only protected against limited amounts of dust and water getting inside. For this reason, the area of flooding will be out of limits for spot and other methods of detection will be required.

4.2 Field of Vision

- 4.2.1 Whilst walking forward, Spot only has a 2.1m wide field of vision. To ensure that spots scanning patterns is clear, he will also be travelling in straight lines and will only change course if he feels the need to avoid an obstacle.

4.3 Spots Go & No Go Areas

- 4.3.1 Spot conducted his first pass so that we could calculate his data collection time and route patterns. Due to the points mentioned in 4.1 and 4.1, his new area of data collection is shown below:



Figure 4: Spot - Workable Area

4.4 Battery Life

- 4.4.1 The maximum useable battery life for Spot is 90 minutes. Knowing this, and his field of view, is possible to calculate how many channels he would require to cover the entire area and therefore, how long it would take him.
- 4.4.2 Firstly, the green section in Figure 4 was measured for area, which returned 9640m^2 .

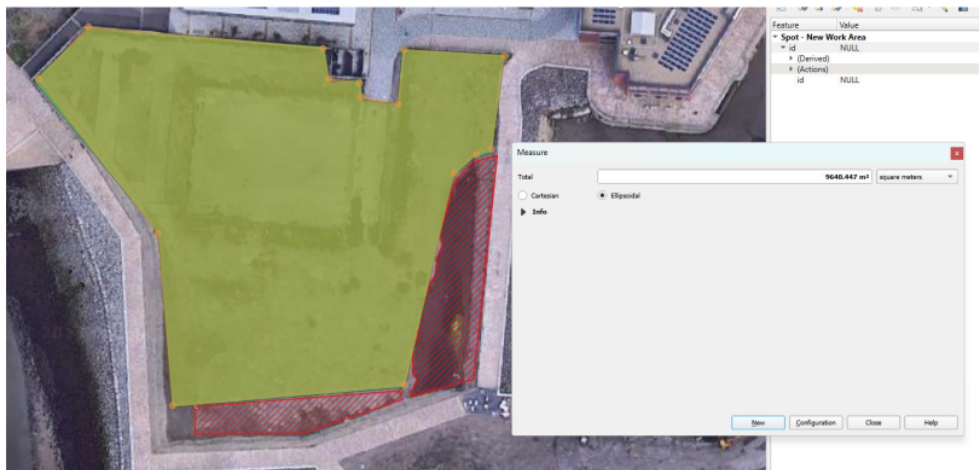


Figure 5: Workable Area

- 4.4.3 The timestamps on the images of spots starting and finishing position was used to estimate the time taken to scan one channel. A line was drawn between these points, which was also measured to establish the channel length and area.

Time between Start and Finish Image = 5 Minutes

Area of Channel = $2.1 * 68.7 = 144.27\text{m}^2$

Maximum coverage on one charge

$90/5 = 18$

$144.27 * 18 = 2598\text{m}^2$

Repetitions required for entire area

$9640 / 144.27 = 66.82$ Reps

66.82 reps would take 334 minutes, or 5.56 hours

Therefore. 4 batteries would be required @ £5000 each

Equation 1: The time taken for Spot to Survey the entire area, Including battery changes.

4.5 Handler Proximity

- 4.5.1 In addition to these points, Spots handler is required to be within 30m of the robot to maintain signal and full operation.
- 4.5.2 A 30m radius was placed within the most central part of spots workable zone, below.



Figure 6: 30m Radius

- 4.5.3 Due to the signal limitations, the handler would be required to enter the potential minefield along with spot.

4.6 Conclusion on Suitability

- 4.6.1 Based on this information, a different method of data collection would be used as Spot is unsuitable for this task.
- The operator would be placed at risk.
 - Areas will be left unsearched.
 - The process would take several hours.

5 Drone

5.1 Contrast

- 5.1.1 United Kingdom law states that drones are prohibited from flying in certain exclusion zones and higher than 120m from the surface. It is the operators responsibility to ensure that the drone is within eye sight at all times, without the aid of binoculars or other enhancing devices.
- 5.1.2 This allows the operator to be suitably clear of the potentially dangerous site.



Figure 7: Drone Operator - Proximity to nearest point of the area of interest

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- 5.1.3 Figure 7 details that the operator was a minimum distance of 30m away from the site at all times.
- 5.1.4 Flying at a height of 30m, the drone was able to scan the entire area in 21 minutes. This was calculated using the drone operator's flight log between take off and landing.

5.2 Settings and Limitations

- 5.2.1 Establishing the correct settings, especially with the IR camera, was crucial to identifying the locations of the landmines.
- 5.2.2 Due to the very soggy ground, and the reflecting sun they did not necessarily stand out due to their heat signatures. Moreso, they stood out due to their non-reflective matt finish. In real time, they appeared as solid blank circles with no contrast. This was useful however, because some mines were hidden in bushes, in deep cold puddles and under metallic objects, blocking their heat signatures.
- 5.2.3 Through filtering and post processing the mines became visible and were recovered. In real world scenarios however, those camera and visual settings will need to be available in real time.

6 Landmine Collection and Logging

6.1 Collection Table

6.1.1 The full list of recovered mines is detailed below :

Table 3: Landmine Locations from Photograph Geotag Data

No.	Location Method	Geotag	Location Comments
1	Drone	51.6163000, -3.9275900	Located within tall grass and shrubbery
2	Drone	51.6163000, -3.9274800	Located within overgrown bushes and weeds
3	Drone	51.6163000, -3.9276000	Located within overgrown bushes and weeds
4	Drone	51.6163000, -3.9276000	Located within tall grass and placed on angle
5	Visual	51.6163000, -3.9270000	Located on banking, submersed within flooding
6	Drone	51.6163000, -3.9272700	Located within overgrown bushes and weeds
7	Drone	51.6163000, -3.9273300	Against fence line, within thick bush
8	Visual	51.6163000, -3.9273700	Out in the open
9	Drone	51.6162000, -3.9272000	Hidden underneath rubbish and metallic objects. Partially submersed
10	Spot	51.6161000, -3.9274700	Hidden underneath rocks
11	Drone	51.6161000, -3.9274700	Submersed in puddle, tennis ball over payload section
12	Drone	51.6160000, -3.9276900	Located within overgrown bushes and weeds

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- 6.1.2 Upon inspection it can be confirmed that the majority of geotagged photographs were accurate in determining the location of the landmines. However, two of the mines (number 5 and 7) were quite a distance from the actual recovered locations. This could be due to the position that the photograph was taken because of their awkward locations.
- 6.1.3 The map projection of the mine locations, along with the actual positions of 5 and 7 are located below:



Figure 8: Landmine Locations

7 Summary

7.1 Remote Sensing

- 7.1.1 The use of remote sensing equipment in this instance was vital in removing the human risk from a landmine detection task. Remote imagery techniques also enables us to scan and evaluate the area of interest beforehand to determine the most efficient method of data collection.
- 7.1.2 The task was completed in a relatively short about of time due to favorable weather conditions and good visibility. The previous days rainfall made the ground very damp, which allowed for a suitable reflective surface for the matt surface landmines to stand out against the sunlight.
- 7.1.3 Given the clear conditions, the drone pilot could easily see the platform throughout the entire operation and during detection of the nearest mine, it was 55m away from the take off point which is almost double what the Spot handler would be away from it, at most.

Matt S - Practical Assignment

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

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PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16